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The effects of low to moderate alcohol consumption and binge drinking in early pregnancy on behaviour in five-year-old children. A prospective cohort study on 1628 children

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Abstract

Objective—To examine the effects of low to moderate maternal alcohol consumption and binge drinking in early pregnancy on behaviour in children at age five years.

Design—Follow-up study

Setting—Neuropsychological testing in four Danish cities 2003–2008

Population—Prospective cohort study of 1,628 women and their children sampled from the Danish National Birth Cohort.

Methods—Participants were sampled based on maternal alcohol drinking patterns during early pregnancy. When the children were 5 years old, the Strengths and Difficulties Questionnaire (SDQ) Parent and Teacher versions were completed by the mothers and a preschool teacher. The

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The findings and conclusions in this report are those of the author(s) and do not necessarily represent the official position of the Centers for Disease Control and Prevention.

Conflicts of interest: none

Contributions

Ulrik Schiøler Kesmodel, Clark H. Denny, Nils Inge Landrø and Erik Lykke Mortensen contributed to the design of the Lifestyle During Pregnancy Study. Åshild Skogerbø wrote the first draft of the manuscript, and Maiken Ina Siegismund Kjærsgaard, Theresa Wimberley and Erik Parner were responsible for the statistical analyses. All authors contributed to the interpretation of the results and with critical comments and revisions of the manuscript.

Ethics

The study was approved by the DNBC Board of Directors, the DNBC Steering committee, the regional Ethics Committee, the Danish Data Protection Agency, and the Institutional Review Board at the Centers for Disease Control and Prevention. Signed informed consent was obtained for the LDPS.

full statistical model included the following potential confounders: Maternal binge drinking or low-moderate alcohol consumption, respectively, parental education, maternal IQ, prenatal maternal smoking, the child's age at testing, the child's gender, maternal age, parity, maternal marital status, family-home environment, postnatal parental smoking, pre-pregnancy maternal BMI, and the child's health status.

Main outcome measures—Behaviour among children assessed by the SDQ parent and teacher forms.

Results—Adjusted for all potential confounders, no statistically significant associations were observed between maternal low to moderate average weekly alcohol consumption and SDQ behavioural scores (OR 1.1, CI 0.5–2.3 and OR 1.1., CI 0.6–2.1 for the total difficulties scores) or between binge drinking and SDQ behavioural scores (OR 1.2, CI 0.8–1.7 and OR 0.8, CI 0.6–1.2).

Conclusion—This study observed no consistent effects of low to moderate alcohol consumption or binge drinking in early pregnancy on offspring behaviour at age 5 years.

Keywords

Prenatal exposures; low to moderate alcohol consumption; binge drinking; neurodevelopmental effects; behaviour; Strengths and Difficulties Questionnaire; SDQ

Introduction

Numerous studies have demonstrated that heavy prenatal alcohol exposure can affect fetal brain development in a number of different ways,[1],[2;3] but the effects of more moderate drinking patterns are much less clear. Both low to moderate weekly consumption of alcohol and binge drinking are examples of consumption patterns which few studies have investigated systematically,[4–6] even though a substantial proportion of women drink at low to moderate levels during pregnancy. Different patterns of alcohol consumption during early pregnancy and the potential effects on children's neuropsychological development have been the focus of a recent comprehensive Danish study. Consistent non-significant effects on intelligence, executive functions, sustained and selective attention, and motor functions were observed. [7–12] Kelly et al.[13] found that up to the age of five years there was no increased risk of poor socio-emotional or cognitive developmental outcomes in children born to mothers who drank no more than 1 to 2 units of alcohol per week during pregnancy. In a large cohort study including nearly 7,500 children no association between prenatal alcohol exposure (1+ units/day in the first 3 months of pregnancy) and general behavioural problems was observed. [14] One of the few studies investigating behavioural difficulties in children exposed to moderate level of alcohol described such children as being more "fidgety" and less compliant.[15]

Traditionally, effects of prenatal alcohol exposure have been evaluated with cognitive desk-tests or computerized tests with less emphasis on behavioural effects observable in the home or in social environments, such as preschool or school. Since hyperactivity and attention deficits are common behavioural difficulties in children who have been exposed to heavy prenatal alcohol consumption[16–18], there is a need to further investigate behavioural effects of low to moderate maternal consumption during pregnancy. The present study is based on

assessment of children's behaviour in real life settings as observed by parents and preschool teachers, and the aim was to analyze the potential effects of low to moderate weekly alcohol consumption and binge drinking during early pregnancy on children's behaviour at the age of five years.

Methods

Study sample

This study formed part of the Lifestyle During Pregnancy Study (LDPS) which has been described in detail elsewhere.[7–12;19] Briefly, the study is a prospective follow-up study based on a sample from the Danish National Birth Cohort (DNBC).[20] The DNBC contains information on 101,042 women and their children. Based on information on maternal alcohol consumption during pregnancy 3,189 mothers and their children were sampled from DNBC participants and invited to participate in a follow-up when the children were between 60 and 64 months of age. Of the invited mother-child pairs 1628 participated in the follow-up. Valid information on binge drinking was missing for 11 of the 1628 mothers, and consequently the binge drinking analyses were conducted on 1617 mothers and their children. Data collection for the follow-up took place from September 2003 to June 2008.

Exclusion criteria were: multiple pregnancies, inability to speak Danish, impaired hearing or vision likely to compromise the ability to perform cognitive tests, and congenital disabilities implying or likely to imply intellectual disability (e.g. trisomy 21, infantile autism).

Exposure assessment

Information on alcohol intake during pregnancy was derived from the first prenatal DNBC interview.[25] For women participating in the follow up, the median week of gestation for completing the interview was 17 weeks (range 7–39 weeks).[7–12] During the interview the women were asked about the average number of beers, glasses of wine, and glasses of spirits they currently consumed during a week, and based on this information, the total number of weekly drinks was calculated. Information on binge drinking during pregnancy included data on the number of binge episodes (defined as intake of ≥5 drinks on a single occasion) and the timing (gestational week) of these episodes. [7–12] The definition of a drink followed the definition from the Danish National Board of Health, with one standard drink being equal to 12 grams of pure alcohol.

All mothers were sampled in strata defined by their average alcohol intake (0, 1–4, 5–8, ≥9 drinks per week) and timing of binge episodes, defined as ≥5 drinks on one occasion in week 1–2, 3–4, 5–8, 9 or later. The higher exposure categories were oversampled in an effort to ensure that all exposure categories included enough children to attain sufficient statistical power.[19] For the analyses presented in this paper, the alcohol consumption categories of 5–8 and ≥9 were collapsed into a 5+ category because of few abnormal and borderline scores in the ≥9 group. Binge drinking was classified as yes/no, number of binge episodes was classified as 0, 1, 2, and ≥3 episodes, timing of episodes was classified as gestational week 1–2, 3–4, 5–8, ≥9, and multiple episodes.

Outcome measures

The Strengths and Difficulties Questionnaire (SDQ) is a brief behavioural screening questionnaire for parents and teachers/pre-school teachers comprising 25 questions on psychological attributes, some positive and others negative (http://www.sdqinfo.com).[21] The 25 attributes cover five domains of behaviour, namely emotional symptoms, conduct problems, hyperactivity/inattention, peer relationship problems, and prosocial behaviour. Scores are derived for each of these domains and the first four domain scores are summed to generate a total difficulties score. It is designed for a broad range of children, age 3 to 16 years.[21] The SDQ is a well-validated measure of childhood mental health.[21;22]

The SDQ was originally developed in England, and a translated Danish version was used in this study.[23] In contrast to British children, Danish children have not yet started school at the age of five. Consequently the wordings of two questions referring to school were changed. The question with words referring to school was changed to kindergarten and the question in the parent version concerning learning abilities was deleted.

We applied the method of score bandings reported by Goodman.[22] Since SDQ scores tend to be quite skewed, the total difficulties score was categorised into normal, borderline and abnormal scores based on cut-offs at the 80th and 90th percentile (lower score is better). The four difficulties sub-scores were dichotomized with cut-off for normal and abnormal scores at the 90th percentile. For the prosocial score higher scores indicate better social functioning, and cut-offs for abnormal, borderline and normal behaviour were set at the 10th and 25th percentile (additionally, analyses of abnormal vs. normal scores were conducted using cut-off at the 10th percentile). When the distribution of the scores did not permit a cut-off at the exact 80th and 90th percentiles for the “borderline” or the “abnormal” band, the cut-off for the next percentile was chosen; this made for under-inclusive rather than over-inclusive bands for the “borderline” and “abnormal” bands.

The large sample enabled us to conduct analyses to evaluate the psychometric characteristics of the SDQ scales in our study population. For the total LDPS sample, Cronbach’s α was 0.76 for the total difficulties score of the parent version, while it was 0.85 for the teacher version of the questionnaire. These figures suggest that the SDQ is a highly reliable instrument.

The follow-up assessments were conducted at four sites located in Copenhagen, Aarhus, Odense and Aalborg. The assessment comprised a comprehensive neuropsychological test battery which is described in detail elsewhere.[19] The parents answered the SDQ parent version as part of a broad questionnaire on the child’s postnatal health/development as well as parental education and lifestyle. The SDQ teacher version was mailed to the kindergarten a few weeks before the planned test date. The completed SDQ was returned to the LDPS research group by mail. A maximum of two reminders were mailed to the parents and/or day-care institutions if they did not respond to the initial letter. [19]

Covariates

The following covariates were obtained in the prenatal interview and subsequently coded as follows: parity (0,1,2+); prenatal smoking (yes/no); and maternal pre-pregnancy BMI

(weight in kg/(height in m)^2). At the time of the 5 year follow-up, the following variables were recorded: maternal marital status (single at either the prenatal interview or follow-up/ with partner at both times); parental education in years (total duration of attained education averaged for both parents or maternal only if information on the father was missing); an index of the quality of postnatal home environments (suboptimal in the presence of ≥2 of the following adverse conditions: living with only 1 biological parent; changes in primary care givers; daycare for more than 8 hours/day before age 3; ≥14 days of separation from parents; breakfast irregularities; maternal depression and maternal/paternal alcohol intake above the official recommendations from the Danish National Board of Health at the time of follow-up; otherwise normal); an index of the child's health status (suboptimal in the presence of any handicaps, illness/diseases and/or medication with potential influence on cognitive test performance; otherwise normal).

Maternal age was obtained from the unique Danish personal identification number, as was sex and age of the child. Birth weight in grams and gestational age in days were obtained from the Danish Medical Birth Registry. Maternal IQ was assessed at the follow-up[7–12] with two verbal subtests (Information and Vocabulary) from the Wechsler Adult Intelligence Scale (WAIS)[24] and Raven's Standardized Progressive Matrices.[25]

In the analyses of maternal average alcohol consumption, binge drinking was included as a potential confounding factor (based on preliminary analyses coded as yes/no in the statistical analysis), whereas the maternal average number of drinks per week during pregnancy was included as a potential confounding factor in the analyses of effects of binge drinking.

Data analysis

The number of missing values for the covariates ranged from 1 to 33. For the SDQ parent total difficulties scale and the parent prosocial scale, information for 10 and 8 children, respectively, were missing, while information was missing for 210 children for the SDQ teacher total difficulties scale and 209 for the teacher prosocial scale. Multiple imputation was conducted with a dedicated model for imputations, where variables were modeled from other variables thought to be most predictive of each variable (the specific equations are available upon request).[7–12] Essentially the same results were obtained when only subjects with full information on the variables needed in any given analysis were included. In this paper we report the results of the dedicated model for imputations, i.e. the results are based on the complete sample with imputed values.

The analyses were conducted with average alcohol consumption and binge drinking as exposure variables. For each type of exposure the parent and the teacher versions of SDQ were analysed. The main analysis was a logistic regression on the dichotomous total difficulties score (abnormal+borderline) vs. normal and on the dichotomous prosocial scale (abnormal+borderline) vs. normal. Supplementary analyses were conducted on the total difficulties scale analyzing abnormal vs. normal and borderline vs. normal, as well as analyzing abnormal vs. normal prosocial scores and borderline vs. normal prosocial scores.

In supplementary analyses, we analyzed potential interactions between average alcohol consumption and binge drinking as well as interactions of the alcohol exposure variables

with sex of child, parental education, and maternal smoking during pregnancy. These variables were dichotomized, and the corresponding strata specific analyses were also conducted. When necessary the number of categories of binge episodes was reduced with the ≥3 category combined with the ≥2 category, and the categories week 5–8 and week ≥9 in the timing of binge episodes were collapsed into a week ≥5 category.

All statistical analyses were conducted in STATA 11 (StataCorp 212 LP, College Station, Texas) and weighted by sampling probabilities. All statistical tests were two-sided and determined significant at the 5% level. All estimates are accompanied by 95% confidence intervals.

Results

Sample characteristics across levels of low to moderate maternal alcohol intake and number of binge episodes in pregnancy are presented elsewhere.[9;10] Notably, women reporting no alcohol consumption during a typical week were significantly younger and had less education than the women in the 1–4 and 5+ drinks per week categories. They were also significantly more likely to be primiparous, less likely to be smokers and less likely to have suboptimal family/home conditions. Smoking and suboptimal family/home conditions were more frequent among women reporting five or more drinks per week.[34] Women without binge drinking episodes were significantly older, less likely to be primiparous, had significantly higher BMI, were less likely to be smokers and had significantly lower IQ compared to bingers.[10]

Results for low to moderate alcohol intake

The results for the SDQ total difficulties scale and the prosocial scale are presented in table 1. For both the parent- and teacher versions no statistically significant effects of low to moderate consumption were observed for either the SDQ total difficulties scale or the prosocial scale. This was also the case for supplementary analyses of abnormal vs. normal scores and borderline vs. normal scores (data not shown).

Analyses for the SDQ parent and teacher subscales (emotional symptoms, conduct problems, hyperactivity/inattention, peer relationship problems) showed no statistically significant associations with average alcohol exposure when adjusting for all potential confounders.

Tests of interactions between low to moderate alcohol consumption and binge drinking dichotomized as well as tests of interactions between low to moderate alcohol consumption and sex, parental education and maternal smoking during pregnancy were statistically non-significant.

Results for binge drinking

We observed no statistically significant effects of abnormal or borderline scores on the SDQ total difficulties and prosocial scales with the dichotomized binge variable, number of binge episodes, or timing of binge episodes (table 2). Further analyses of abnormal vs. normal

scores and borderline vs. normal scores showed no significant associations of SDQ scores with binge drinking.

Analyses for the SDQ parent and teacher subscales (emotional symptoms, conduct problems, hyperactivity/inattention, peer relationship problems) showed no statistically significant associations with binge drinking when adjusting for all potential confounders.

Tests of interactions with the dichotomized variables sex, parental education, and maternal smoking during pregnancy were not statistically significant. However, for the parent version of the SDQ total difficulties scale the interaction between number of binge drinking episodes and average alcohol consumption was statistically significant, even after adjusting for all potential confounders (p=0.01). Stratified analyses showed a significantly elevated risk for a high score (abnormal and borderline collapsed) in children whose mothers had two binge episodes during early pregnancy and drank 5 or more drinks per week (p=0.03). However, three or more binge episodes were not associated with elevated risk, and thus the result did not consistently suggest stronger effects of binge episodes in women consuming 5 or more drinks per week.

Intercorrelations and interrater agreements among SDQ scores

Because the distributions of SDQ scores were skewed, Spearman's correlations were calculated to evaluate associations between SDQ scores. For the SDQ parent version the correlation between the total difficulties scale and the prosocial scale was −0.29. For the SDQ teacher version the correlation between the total difficulties scale and the prosocial scale was −0.52. Additionally, the correlations across the corresponding SDQ parent and teacher scales were analyzed. The correlation between the parent total difficulties scale and the teacher total difficulties scale was 0.34, and for the parent prosocial scale and the teacher prosocial scale the correlation was 0.25.

Discussion

The present study examined the potential effects of low to moderate prenatal alcohol exposure and binge drinking on behaviour of children at age five years. No statistically significant effects were observed for low to moderate weekly alcohol consumption levels during early pregnancy and no consistent associations between binge drinking during early pregnancy and child behaviour were observed. No consistent evidence of interaction between binge drinking episodes and average alcohol consumption was found.

Limitations and strengths

SDQ is a measure of children's behavioural difficulties and strengths in daily life, and the possibility that the SDQ is not sensitive enough to detect subtle effects of low to moderate prenatal alcohol exposure should be considered. However, the SDQ and the well known Child Behaviour Checklist (CBCL) correlate highly,[26] the two questionnaires appear to be equally able to discriminate between children drawn from high-risk and low-risk samples. Furthermore, the lack of significant effects of low to moderate prenatal exposure and binge drinking on behaviour are corroborated by the analyses based on the BRIEF parent and teacher ratings of executive functions in 5-year old LDPS children.[8] For both the SDQ and

the BRIEF the correlations between the parent and teacher ratings were low, but this may primarily reflect the fact that the parents obvserve the child in a family context while the kindergarten teacher observes the child together with other children of the same age.

A possible limitation of our study is the age of the children at the time of the follow-up since a child's behaviour, including social and emotional functioning, continues to develop and is unlikely to remain stable throughout childhood and adolescence. On the one hand this means that any observed effects of prenatal alcohol exposure at age five may not reflect permanent deficits, on the other hand it also means that developmental problems associated with maternal drinking during pregnancy may emerge later in childhood[13;27]

As with all active participation studies, potential differences between those who agreed to participate and those who did not must be considered. While the 51% participation rate for this study is quite good for studies of this nature, and no notable differences between LDPS participating and non-participating mothers have been observed[9,10], the possibility remains that mothers of children who were not cognitively or behaviourally functioning at age level may have been more likely to decline participation.

As with any study of teratogenic effects, limitations in exposure measurement must be acknowledged. If the damaging effects of alcohol depend on the maximal blood concentration, number and timing of binge drinking episodes would be only indirect estimates of such exposures. The blood concentration depends not only on the volume of alcohol consumed, but also on the duration of drinking as well as on the blood volume and speed of enzymatic breakdown; consequently the observed estimates of the relationship between binge drinking and behaviour are likely to be conservative estimates.

In this study, information on average alcohol use reflects the specific time of the prenatal interview which varied from 7 weeks to 39 weeks. Any interactions of timing with exposure and with the specific unfavorable behaviours may have been diluted if either were sensitive to a specific gestational time period. If harmful effects of average maternal consumption or binge drinking occur mainly later in pregnancy (i.e., in the late second or third trimester) when the growth and development of the central nervous system is rapid, our study could not assess such risk.

In general, information bias, in particular misclassification because of underreporting, is a possibility in all studies of alcohol intake during pregnancy since reliable biomarkers currently are not available. Compared to other studies, underreporting in this study may have been reduced both because we used methods shown to yield valid and reliable information among Danish pregnant women,[28; 29;30–32] and because consumption of small amounts of alcohol during pregnancy was generally not considered to be problematic in Denmark during the time of data collection.[33]

Finally, in studies with null effects, lack of sufficient statistical power must be considered, especially when potentially subtle effects are investigated. In this study and the other LDPS studies the small number of women drinking more 9 or more drinks per week is an obvious weakness.

Even so, the LDPS has important strengths compared to many previous studies, in particular the large sample consisting of a relatively homogenous population of middle-class women who generally are not stigmatized for consuming small amounts of alcohol during pregnancy. In addition, the LPDS includes a wide range of potential confounders. None of the previous studies of alcohol and behaviour adjusted for all of the confounders included in this study. In particular we controlled for maternal IQ and parental education which are important confounders that may have resulted in residual confounding in many previous studies.

Interpretation

There are a number of previous reports of effects of heavy alcohol exposure on behaviour and neurobehavioural outcomes,[34–36] but studies evaluating the effects of low amounts of alcohol are rare. Recently, LDPS studies of low to moderate maternal alcohol consumption and binge drinking during early pregnancy have consistently observed non-significant associations with intelligence, executive functions, sustained and selective attention as well as motor functions.[7–12;37] These results are consistent with the findings of the present study which are also consistent with a recent British study using SDQ as one of several outcomes. This study observed no increased risk of socioemotional difficulties or cognitive deficits in children born to light drinkers compared with children born to mothers that did not consume any alcohol during pregnancy. [13] Two Australian studies have used the Child Behaviour Checklist (CBCL)[26] to evaluate effects of prenatal alcohol exposure: One study found no evidence of increased risk of behavioural problems in children exposed to light or moderate consumption.[38]. The other study confirmed the results for light consumption, but found increased risk associated with moderate or higher exposure.[39] The latter study controlled parental income, but not parental education or maternal intelligence which tend to be the most important confounders in studies of neurobehavioural outcomes.

The lack of statistically significant findings in the present study suggests that any true effects of low to moderate alcohol consumption and maternal binge drinking on child behaviour may be subtle and difficult to detect with current measures of neurodevelopment such as the SDQ, or that there are no effects. A null effect always raises the possibility that the study design and the chosen measures were not sensitive enough to detect a true effect. However, for low maternal consumption our results are supported by consistent negative findings in previous studies and in LDPS studies with behavioural and cognitive outcomes. For average consumption in the LDPS, the exposure primarily represented the lower tail of the distribution for the low and moderate consumption categories, suggesting that our findings are more in line with occasional weekly drinking (1–2 drinks) or at most, levels of less than one drink per day. Thus, a conservative interpretation of the LDPS studies is that 1–2 drinks per week were not associated with detectable effects on offspring behavioural and cognitive development. For binge drinking the observed lack of association can obviously not be generalized to studies using other definitions of binge drinking or focusing on different timing in relation to pregnancy.

In a public health perspective it is important that neither the LDPS studies nor the general scientific literature have established a safe level of alcohol consumption during pregnancy,

and that low and moderate maternal alcohol consumption and binge drinking may compromise other developmental outcomes and increase the risk for other adverse outcomes such as fetal death.[40] Consequently, negative findings in studies of behavioural and cognitive development should not alone lead to changes in health policies and therefore, conservative advice is for women to abstain from alcohol, a known teratogen, during pregnancy.

Future studies of the possible effects of minimal alcohol consumption during pregnancy should be designed to overcome the potential weaknesses of the LDPS studies. They should include more precise assessment of exposure with possible biological markers of alcohol consumption, a large sample with concomitant statistical power, and comprehensive outcome assessments at different ages.

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Table 1

Effects of maternal low-moderate alcohol consumption in pregnancy on offspring mean SDQ[1] scores[2], Denmark 2003–2008.

	Parent rated SDQ total scale (abnormal +borderline)[3]		Parent rated SDQ prosocial score (abnormal+borderline)		Teacher rated SDQ total scale (abnormal+borderline)		Teacher rated SDQ prosocial scale (abnormal+borderline)	
	Odds ratio[4]	**95% CI**	**Odds ratio**	**95% CI**	**Odds ratio**	**95% CI**	**Odds ratio**	**95% CI**
Average no.drinks/ week in pregnancy								
0 (N=758)	Reference	-	Reference	-	Reference	-	Reference	-
1–4 (N=675)	1.1	[0.7; 1.7]	0.9	[0.6; 1.3]	0.9	[0.6; 1.4]	0.9	[0.6; 1.3]
5+ (N=195)	1.1	[0.5; 2.3]	1.0	[0.5; 2.0]	1.1	[0.6; 2.1]	1.1	[0.5; 2.3]
p-value[5]	*0.90*		*0.85*		*0.91*		*0.68*	

[1] The Strengths and Difficulties Questionnaire

[2] SDQ total difficulties scale and SDQ prosocial scale

[3] The abnormal and borderline range: Three binary scores are generated indicating abnormal vs. normal, borderline vs. normal, and (abnormal+borderline) vs. normal in case of the total difficulties score and the categorised prosocial score. Only the abnormal+borderline range is reported in the table, representing the range for children behavioural difficulties.

[4] Adjusted for all potential confounders: parental education, maternal IQ, prenatal maternal smoking, age at testing and gender of child, binge drinking, maternal age, parity, maternal marital status, family home environment, postnatal parental smoking, pre-pregnancy maternal BMI, and the child's health status.

[5] *P*-value for the hypothesis of no difference in SDQ-scores across levels of average alcohol intake.

Table 2

Effects of maternal binge drinking in pregnancy on offspring mean SDQ[1] scores[2], Denmark 2003–2008.

	Parent rated SDQ total scale (abnormal+borderline)[3]		Parent rated SDQ prosocial scale (abnormal+borderline)		Teacher rated SDQ total scale (abnormal+borderline)		Teacher rated SDQ prosocial scale (abnormal+borderline)	
	Odds ratio[4]	**95% CI**	**Odds ratio**	**95% CI**	**Odds ratio**	**95% CI**	**Odds ratio**	**95% CI**
Binge drinking in pregnancy								
No (N=495)	Reference	-	Reference	-	Reference	-	Reference	-
Yes (N=1122)	1.2	[0.8; 1.7]	0.9	[0.7; 1.2]	0.8	[0.6; 1.2]	1.1	[0.8; 1.6]
p-value[5]	*0.37*		*0.53*		*0.25*		*0.46*	
Number of binge drinking episodes in pregnancy								
0 (N=495)	Reference	-	Reference	-	Reference	-	Reference	-
1 (N=783)	1.3	[0.9; 1.9]	1.0	[0.7; 1.3]	0.8	[0.6; 1.2]	1.1	[0.8; 1.6]
2 (N=225)	0.9	[0.5; 1.5]	0.7	[0.4; 1.1]	0.9	[0.5; 1.5]	1.2	[0.7; 2.1]
≥3 (N=114)	1.1	[0.5; 2.1]	1.1	[0.6; 2.0]	0.6	[0.3; 1.3]	1.3	[0.7; 2.4]
p-value[5]	*0.36*		*0.42*		*0.52*		*0.82*	
Timing of binge drinking episodes in pregnancy (gestational week)								
No binge drinking (N=495)	Reference	-	Reference	-	Reference	-	Reference	-
1–2 (N=237)	1.3	[0.8; 2.1]	0.8	[0.5; 1.2]	0.8	[0.5; 1.3]	1.2	[0.8; 1.9]
3–4 (N=261)	1.4	[0.9; 2.2]	1.0	[0.7; 1.5]	0.8	[0.5; 1.2]	0.9	[0.6; 1.5]
5–8 (N=216)	1.0	[0.6; 1.7]	0.9	[0.6; 1.5]	1.0	[0.6; 1.6]	1.3	[0.8; 2.1]
≥9 (N=234)	1.2	[0.7; 1.9]	1.0	[0.6; 1.6]	1.1	[0.7; 1.8]	1.4	[0.8; 2.3]
Multiple episodes (N=174)	0.8	[0.5; 1.4]	0.8	[0.5; 1.3]	0.7	[0.4; 1.3]	1.3	[0.8; 2.2]
p-value[5]	*0.44*		*0.90*		*0.59*		*0.60*	

[1] The Strengths and Difficulties Questionnaire

[2] SDQ total scale and SDQ prosocial scale

[3] The abnormal and borderline range: Three binary scores are generated indicating abnormal vs. normal, borderline vs. normal, and (abnormal+borderline) vs. normal for the total difficulties score and the categorised prosocial score. Only the abnormal+borderline range is reported in the table, representing the range for children behavioural difficulties.

[4] Adjusted for all potential confounders: parental education, maternal IQ, prenatal maternal smoking, age at testing and gender of child, low-moderate alcohol consumption, maternal age, parity, maternal marital status, family-home environment, postnatal parental smoking, pre-pregnancy maternal BMI, and the child's health status.

[5] *P*-value for the hypothesis of no difference in SDQ-scores across levels of binge drinking.